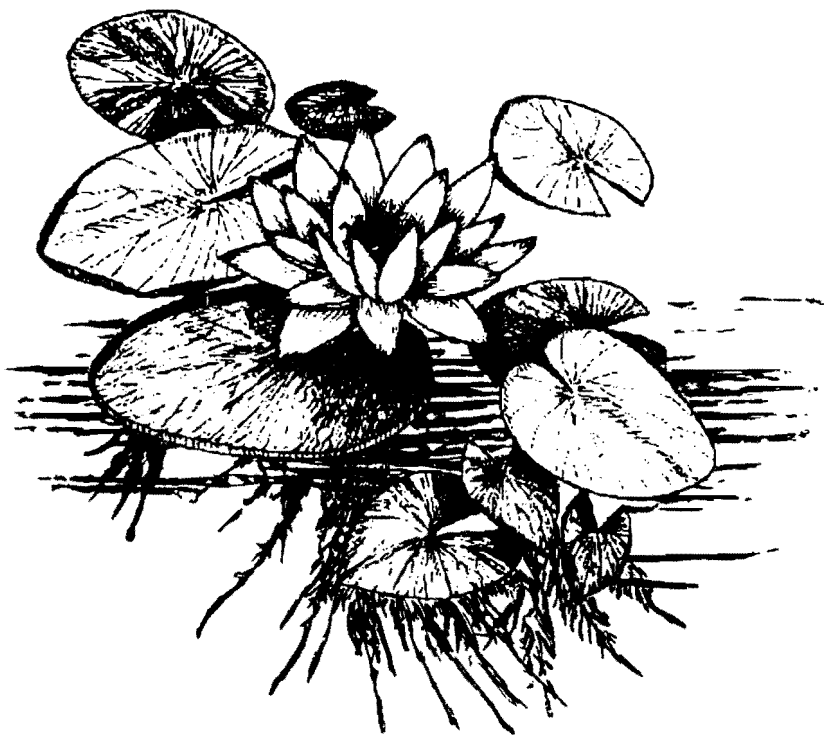
ABSTRACTS

Aquatic Plant Management Society, Inc.



Thirty-Ninth Annual Meeting
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Session I

Navigating the 90s - Aquatic Plant Control in Florida.

Jeff Schardt, Florida Department of Environmental Protection, Tallahassee, FL

Temporary setbacks and tremendous gains characterize Florida's aquatic plant management program in the 1990s. After decades of disagreements and fears related to water hyacinth management, most people now endorse Florida's maintenance control approach. Water hyacinth coverage is negligible, native shoreline vegetation is abundant, and fisheries remain vibrant. Hydrilla management funding declined in the early 1990's sparking an outbreak from 40,000 -- 140,600 acres in public waters. This environmental and economic disaster quieted the debate in Florida regarding the exploitation of invasive species for resource management. Anglers, property owners, flood control, and aquatic plant managers presented a united front to legislators on the urgent need for sufficient, recurring invasive plant control funding. The legislature responded by providing interim funding during the late 1990's to begin the maintenance control process for hydrilla, and managers reduced the standing crop below 40,000 acres. Fisheries reports are excellent from across the state in waters that had been virtually unusable only five years ago.

Along the way during the 1990s, resource users and managers as well as policy makers have gained a deepening knowledge and respect for problems caused by invasive plants in Florida. The legislature was impressed by the problems posed by such plants as hydrilla and melaleuca, and the success of managers in reducing these problems when given the opportunity, So impressed that legislation was passed during the 1999 session to ensure sufficient, recurring funds to manage all invasive aquatic plants in Florida public waters for the next decade. A pilot upland invasive plant management program, modeled after the aquatics program, was authorized in 1998 and fully funded beginning in 2000.

The Santee Cooper Lakes: Lessons Learned After 10 Years.

Steven J. de Kozlowski, SC Department of Natural Resources, Columbia, SC

The 170,000 acre Santee Cooper Lakes system, comprised of Lakes Marion and Moultrie, is the largest and one of the most important multipurpose freshwater resources in South Carolina. An expanding hydrilla population, which displaced desirable native plant species and impaired a variety of water use activities in up to 48, 000 acres, threatened to infest over 50% of the lake system. As part of an integrated management strategy, sterile grass carp were incrementally stocked between 1989 and 1996 to provide long-term control of hydrilla. A discussion of the effectiveness of stocking a large lake system, hydrilla and other aquatic vegetation coverage, water use benefits and concerns, and future plans will be presented.

Aquatic Plant Management in Minnesota: The Past Ten Years.

Wendy Crowell, and Steve Enger, Minnesota Department of Natural Resources, Ecological Services Section,
St. Paul, MN.

The Minnesota Department of Natural Resources is responsible for regulating the destruction of aquatic plants in Minnesota. MNDNR works to balance the rights of riparian land owners with its obligation to protect the resource. Over the past ten years, the DNR Aquatic Plant Management Program, and the DNR Exotic Species Program, have become more active in the management of exotic aquatic plants, particularly purple loosestrife, Eurasian watermilfoil and curly-leaf pondweed. Because these exotics are harmful to natural ecosystems the DNR has taken a more active role in managing these plants. In addition, the MN DNR is investigating ways to improve control methods for those species.

Washington Report.
Rob Hedberg, Director of Science Policy, Weed Science Society of America, Washington, D.C.

On February 3rd the Weed Science Society of America, together with the Aquatic Plant Management Society and four regional Weed Science Societies (NCWSS, NEWSS, SWSS and WSWS) initiated the new Director of Science Policy position. Fortuitously, the Executive Order on Invasive Species was also signed that day. Just as national attention and resources were focused on management of invasive species, the societies focused attention and resources on building stronger relationships with the government's legislative and administrative branches. As public awareness of weed problems rises we have an excellent opportunity to build understanding of our science through our new Washington presence.

Aquatic Ecosystem Restoration Foundation... Three Years of Progress.
Michael Moore, Executive Director, Aquatic Ecosystem Restoration Foundation, Lansing, MI

The Aquatic Ecosystem Restoration Foundation is a scant three years old but its impact has been felt throughout the aquatic plant management community. Executive Director Mike Moore will give an update of completed and underway research, discuss the educational symposia held around the nation, and outline future activities.

NOTES

Session II

Evaluation of Fluridone for Hydrilla Control in New Zealand.

D. E. Hofstra and J. S. Clayton, National Institute of Water and Atmospheric Research, Hillcrest Hamilton, New Zealand

Hydrilla Verticillata was treated with fluridone at initial concentrations between 10 and 150 ppb in growth tanks at two different light levels (90% shade and 30% shade) for five months over the summer of 1998-1999. Differences in plant appearance and biomass between treatment and control tanks were apparent during the five months. And are compared with results obtained in earlier New Zealand trials which were reportedly unsuccessful based on a shorter three month contact time.

Contact Herbicide Combination Efficacy Evaluations. (WU# 32437)

J. G. Skogerboe, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX and K. D. Getsinger, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS

Efficacy studies were undertaken to evaluate the potential for using the aquatic herbicides, Aquathol K (endothall) and Reward (diquat), combined with the chelated copper, Clearigate at low concentrations and short exposure periods (6 hr) to control Eurasian watermilfoil (Myriophyllum spicatum), hydrilla (Hydrilla verticillata), and egeria (Egeria densa). Studies were conducted in 50-L, temperature-controlled aquaria in a greenhouse at the Lewisville Aquatic Ecosystem Research Facility in Texas. Combinations of Aquathol K (1.5 mg/L endothall) plus Clearigate (0.25 mg/L copper) and Reward (0.45 mg/L diquat) plus Clearigate (0.5 mg/L copper) were applied to the target species, and those combinations were compared to Aquathol K (1.5 mg/L endothall), Reward (0.45 mg/L diquat) and Clearigate (0.9 mg/L copper) applied alone. Results showed that combining Reward and Clearigate significantly increased efficacy on hydrilla. Combinations of Aquathol K and Clearigate increased efficacy on hydrilla and egeria. Clearigate and Reward were each effective in controlling egeria.

Phytotoxins in the Real World: Understanding the Role of Cattail Products in Aquatic Weed Management.

Maria T. Gallardo and Dean F. Martin, Institute for Environmental Studies, Department of Chemistry, University of South Florida, Tampa, FL.

As we make progress in our understanding of the complex nature of natural phytotoxins from cattails, it becomes apparent that the potential for use as weed management agents depends on finding suitable delivery methods. The study of the relationship between concentration and activity makes it possible to identify a range of active concentrations. We will discuss the factors that decrease the potency of cattail extracts and also the use of cattail tissue as a biodegradable mulch that can be use for temporary inhibition of aquatic weed growth.

Student Paper

Evaluation of Five Surfactants with Imazapyr for Control of Cattails (Typha latifolia).

S.T. Hoyle, S.H. Kay, Crop Science Department, North Carolina State University, Raleigh, NC.

Field tests were initiated in the fall of 1997 and 1998 to determine the influence of different surfactants on the efficacy of Arsenal for control of cattails in roadside ditches. A single application of imazapyr was applied at either 2 or 4 pints/acre with five chemically different surfactants at 0.25% v/v. Percent dead stems 6 WAT imazapyr al 4 pt/A - 86.5, 2 pt/A -80.7, non-treated - 28. 1. Evaluations 7 months after treatment showed no new growth with 4 of 5 surfactants with imazapyr at the high rate. No off target effects were noted.

Magnitude of the Residues of Endothall in Freshwater Fish and Shellfish.

Janice K. Sharp, Ph.D., Elf Atochem, N.A., King of Prussia, PA; Emily Dionne, Springborn Laboratories, Wareham, MA; Mike Grisham and Timothy Formella, ABC Laboratories, Columbia, MO

A Magnitude of Residue study was conducted by exposing bluegill sunfish, catfish, crayfish, and freshwater clam to 3.6 ppm endothall for seven consecutive days. Animals were placed in 1000 liter tanks and dosed with radiolabeled endothall dipotassium salt in the presence of 1 kg/1000 L of coontail plants, Ceratophyllum sp. Samples were taken at 2 hours, 12 hours, 1 day, 2 days, 3 days, 5 days and 7 days. Endothall residues in the tanks maintained between 3.7 to 2.8 ppm throughout the seven day exposure. Significant radiolabel was rapidly absorbed by the aquatic plants before they died at 3 days. Bluegill and catfish showed extremely low levels of endothall at or below the quantitation limit of 0.020 ppm throughout the seven day exposure. Crayfish showed more uptake of endothall with maximum residues of 0.23 ppm endothall at 5 days exposure. Clams showed the highest uptake of residues with maximal residues of 1.1 ppm at 5 days and start of a decline of residues at 7 days. These data demonstrate endothall is barely absorbed by fish and not bioaccumulated in any of the four aquatic animal species. The study also showed that clams, the animal species that absorbed the most endothall, displayed the same metabolic pathway seen in plants, rat, goat, and hen. In all cases endothall was rapidly metabolized into natural products and components, of the organism. These data are further evidence of the safety of endothall in the aquatic environment manifested by low absorption and rapid metabolism in aquatic organisms.

New From Monsanto, "Quicksorb."

Lonnie M. Pell, Monsanto, Merritt Island, FL

Brazilian Pepper has spread throughout South Florida, causing problems in several areas. Results of the University of Florida research on Brazilian Pepper conducted in 1997 and 1998 will be presented. This includes application techniques and rates of Rodeo mixed with a new Monsanto product, Quicksorb. Features, advantages and benefits of Quicksorb for uses in aquatic and upland sites will be presented.

An Evaluation of Microbial Products and Chemical Algaecides Used In Surface Water Management.

Robert J. DuVall, Lars W. J. Anderson, and Charles R. Goldman, USDA/ARS Aquatic Weed Laboratory, University of California, Davis, CA

Aqua-5, Lake Pak, WSP, Bacta-Pur, copper sulfate and Diquat were examined for their ability to reduce planktonic algae growth. Lexan cylinders (diameter 38 cm, height 122 cm) were pushed into the clay bottom of replicated ponds to form watertight microcosms in which the products were applied according to the manufacture's label. Chlorophyll a concentrations and bacterioplankton cell counts were monitored for three weeks. Nitrogen, phosphorus and micronutrients were added four days after treatment to stimulate algal growth. Following nutrient enrichment, chlorophyll concentrations in the cylinders previously treated with copper sulfate were significantly lower than in the non-treated controls. However, in the tubes previously treated with Diquat, chlorophyll and bacterioplankton increased relative to the non-treated controls. Both chemical treatments reduced or eliminated zooplankton and macrophytes. Chlorophyll in the cylinders treated with the microbial products was not significantly lower than in the non-treated controls.

Student Paper

Triclopyr Efficacy Evaluation Against Variable-Leaf Watermilfoil. (WU# 32841).

Susan L. Sprecher and Kurt D. Getsinger, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS

The perennial variable-leaf (or various-leaved) watermilfoil (Myriophyllum heterophyllum Michx.) is native in North America from eastern Canada to South Dakota and to Florida, and can be found in relatively acid, low alkalinity, and nutrient-poor bodies of water. However, it is not native in New Hampshire, and, since its initial discovery there in the 1960's, this plant has essentially taken on the function of an exotic nuisance species, analogous to the role Eurasian watermilfoil (Myriophyllum spicatum L.) plays in other northern tier states. Variable-leaf watermilfoil spreads primarily via clonal reproduction to produce monotypic stands of weedy, competitive, and undesirable perennial growth, and has colonized 36 bodies of water in New Hampshire, having been present in most of these for over five years. As it seldom forms emergent heterophyllous flower-bearing stems, the species has probably not generated a significant local seedbank. This lack of potential for regrowth from seed and its presence in a relatively limited number of sites means that variable-leaf watermilfoil is highly amenable to local control via herbicides. Triclopyr (3,5,6-trichloro-2-pyridinyloxyacetic acid) herbicide is effective in controlling Eurasian watermilfoil, but there is less information on how effective or selective this compound is on native watermilfoils that present weed problems. Growth chamber evaluations of triclopyr efficacy on variable-leaf watermilfoil showed that characteristic symptoms of auxin-like injury and necrotic stem lesions were produced by 0.5 to 2.0 mg ae triclopyr L^{-1} applied for 24 hr, and that treatment reduced biomass. These initial results suggest that combinations of higher concentrations and longer exposure times will be required for significant reduction in growth and control of M. heterophyllum.

Impacts of Inorganic Turbidity on Diquat Efficacy versus Egeria densa. (WU# 32437)

A. G. Poovey, AScI Corporation, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS and K. D. Getsinger, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS

In clear water, diquat can provide excellent plant control at low concentrations (<0.5 mg/L); yet, it is well known that turbid water conditions can interfere with the activity and effectiveness of diquat. Aside from extremes of "muddy" of "clear" water, little work has been done to quantify the relationship between diquat efficacy and turbidity. Results from recent growth chamber studies indicated that relatively moderate levels of turbidity (5 to 15 NTU), using montmorillonite clay (CEC - 35 meg/100 g) from Texas ponds, diquat rates of 1 to 2 mg/L provided acceptable control of egeria at 15 NTU. Determination of quantitative relationships between efficacy and common sediment types would prove useful for predicting plant control using diquat.

Selective Use of Endothall to Manage Aquatic Vegetation. (WU#32841)

J. G. Skogerboe, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX and K. D. Getsinger, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS

Species selectivity of the aquatic herbicide endothall (as Aquathol K) was evaluated on plants commonly found in southern and northern latitude water bodies. These studies were conducted in 7000-L outdoor mesocosms at the Lewisville Aquatic Ecosystem Research Facility in Texas using rates of endothall from 0 through 5 mg/L, and utilizing a simulated 24-hr chemical dissipation half-life. Exotic plant species evaluated included Eurasian watermilfoil, hydrilla, and curly-leaf pondweed, while native species included sago pondweed, Illinois pondweed, American pondweed, coontail, elodea, wild celery, southern naiad, waterstargrass, bulrush, smartweed, cattail, pickerelweed, spatterdock, and fragrant waterlily. Eurasian watermilfoil, hydrilla, and curly-leaf pondweed were controlled at recommended application rates. Sago pondweed, wild celery, and Illinois pondweed were significantly injured following treatments, but regrowth occurred by 8 weeks posttreatment. Other submersed species were injured at some application rates, but recovered quickly during posttreatment. Emergent plants were not significantly injured at any application rates.

Selectivity of Fluridone for Management of Eurasian Watermilfoil: Whole-lake, Low-dose Boost Application Technique. (WU#32437)

K. D. Getsinger, J. D. Madsen, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS; T. J. Koschnick, M. D. Netherland, SePro Corporation, Carmel, IN; R. M. Stewart, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS; D. R. Honnell, AScI Corporation, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX; and A. G. Staddon Netherland, SePro Corporation, Carmel, IN

In an effort to document the selective control of Eurasian watermilfoil, four Michigan lakes were treated with Sonar AS at a calculated whole-lake initial concentration of 5 mg/L fluridone. The 3-m depth contours delineated lake volumes used for the calculated treatment rates. At 14 days after treatment (DAT), these lakes were re-treated (boost application) with the required Sonar AS to re-establish a calculated whole-lake concentration of 5 mg/L. Immunoassay (FasTEST) water residue analysis techniques were used to ascertain the amounts of herbicide needed for the 14 DAT boost treatments and to monitor fluridone water concentrations through 90 DAT. Immunoassay and HPLC methods were also compared. Water residue data were matched with plant community assessment data to explain fluridone efficacy against the target species, to document effects on non-target vegetation, and to verify results of fluridone mesocosm selectivity studies.

Selectivity of Fluridone for Management of Eurasian Watermilfoil: Efficacy on Eurasian Watermilfoil and Response of Native Plants in Four Michigan Lakes. (WU# 32841)

John D. Madsen, K. D. Getsinger, R. M. Stewart, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS; C. S. Owens, AScI Corporation, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX; D. H. Smith, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX; and T. J. Koschnick, SePRO Corporation, Carmel, IN

In the past, fluridone (SONAR) has often controlled both non-target native species as well as the target plant, resulting in use restrictions in many states. Recent mesocosm studies have indicated that fluridone can be used selectively to manage Eurasian watermilfoil and not impact native species. Building on this experience, we evaluated treatments in four lakes at 5 mg/L fluridone (as Sonar AS) in mid-May 1997, with a subsequent boost treatment back to 5 mg/L fluridone after 14 days. The vegetation of the four treatment lakes and four untreated reference lakes were quantified using a point intercept technique, with 200 to 300 points per lake, in May and August of 1997 and 1998. In the three lakes which maintained adequate fluridone for over 60 days, Eurasian watermilfoil was significantly reduced with no impact to native species. In one treatment lake with inadequate fluridone concentration and exposure time, Eurasian watermilfoil was not reduced. Our study documents that fluridone may be used selectively to manage Eurasian watermilfoil, but the concentration range between selectivity and broad-spectrum control on the one hand, and failure to control Eurasian watermilfoil on the other, is very slim and requires careful calculation of dose and frequent analysis of intake fluridone concentration.

Diuron 24 (c) Registration for Florida Tropical Fish Production Ponds.

Chance W. DuBose, University of Florida, Gainesville, FL; Dr. Ken A. Langland, University of Florida, Gainesville, FL

Difficult to control algae prompted the Florida Tropical Fish Farms Association (FTFFA) to seek a special local needs (SLN) label for diuron. Rate screening, in concrete tanks at Gainesville, Florida show that diuron gave 100% control of Chara sp. at all concentrations (0.25-2.0 mg l-') with no significant difference between treatments (p-value > 0.95). Field efficacy and dissipation evaluation, in fish ponds, gave 100% control at all concentrations (0.20-1.31 mg l-'), with no significant differences between treatments (p-value > 0.95). Diuron half-lives ranged from 17 to 28 days (0.20-1.31 mg l-'). Toxicity to zebra danio (Brachydainio rerio) was conducted in 30, 37.8 liter aquaria at Ruskin, Florida. Diuron concentrations ranged from 0 to 25 mg l-'. The 96 Hour Toxic Dose to effect 50% of test fish was 6 mg l-'.

Student Paper

Effects of a 2,4-D Treatment on Eurasian Watermilfoil and Native Plant Communities in Loon Lake, Washington.
Kathy Hamel, Washington Department of Ecology; Jenifer Parsons, Washington Department of Ecology; John Madsen, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS.

Pioneering colonies of Myriophyllum spicatum (milfoil) were discovered in September 1996 in 1,100 acre Loon Lake. In 1997, milfoil was hand pulled by divers and larger colonies were covered with bottom barriers. However, milfoil continued to expand. In 1998, 2,4-D was applied. Aquatic plant frequency and biomass data were collected before and six weeks after application to determine impacts to milfoil and native plants. Results showed a significant decrease in the frequency and biomass of milfoil in treated areas, with no significant impact to native vegetation. Scattered individual milfoil plants were largely untreated, and showed no significant change in frequency.

NOTES

Session III

Sediment Resuspension Dynamics in Canopy- and Meadow-Forming Submersed Macrophyte Communities. (WU# 33128)

William F. James, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Eau Galle Aquatic Ecosystem Research Facility, Spring Valley, WI; John W. Barko, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS; Eva-Maria Koch, University of Maryland at Horn Point, Horn Point Environmental Laboratory, Cambridge, MD; and David P. Hamilton, Centre for Water Research, The University of Western Australia, Nedlands WA 6907, Australia

We examined the influences of submersed macrophyte communities dominated by canopy-forming (Myriophyllum sibiricum) and meadow-forming (Chara sp.) species on shear stress properties and sediment resuspension in Lake Christina, Minnesota. Much of the lake is very shallow (<1.5 m) with effective fetches greater than 1 km in the direction of prevailing winds. Sediments in the lake are flocculent (moisture content > 80%) and exhibit a critical shear stress of only about 1.5 dynes/cm2, making them very susceptible to sediment resuspension at wind speeds >15 to 20 km/h. At these wind speeds, both the Chara sp. and the M. sibiricum community effectively reduced shear stress at the sediment-water interface well below the critical sediment shear stress. Sediment resuspension was also minor in both communities even under high wind speeds. This research provides important information on the roles that submersed vegetation architecture play in regulating sediment resuspension/nutrient dynamics in aquatic systems.

Molecular Markers: Useful for Decision Making in Biocontrol Weed Management.

Paul T. Madeira, Dr. Thai K. Van, and Dr. Ted D. Center, USDA-ARS, Aquatic Weed Control Research, Ft. Lauderdale, FL.

Molecular markers am presented as an aid to understanding the underlying phylogenetic and/or population structure of aquatic weeds and their biological control agents. Especially useful arc RAPD markers which produce large numbers of DNA fingerprints. Examples include the use of RAPD to track the origins of the US hydrilla biotypes and to monitor range expansion within the US. A study of divergence in two Australian sources of the melaleuca biocontrol weevil (Oxyops vitiosa) is presented with it's implications on the need to repeat host specificity testing which had been conducted on one population.

Emergence of Vegetative Propagules of Potamogeton nodosus, Potamogeton pectinatus, Vallisneria americana, and Hydrilla verticillata Based on Accumulated Degree-Days in Texas and California.

David F. Spencer, Gregory G. Ksander, USDA-ARS Exotic and Invasive Weed Research Unit, U.C. Davis, Davis, California; John D. Madsen, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS; and Chetta S. Owens, USAE-WES Lewisville Aquatic Ecosystem Research Facility, Lewisville, Texas.

Many species of rooted aquatic plants persist because they produce underground vegetative propagules. Previous studies using constant temperatures have indicated that propagule sprouting is in part regulated
by temperature. The purpose of this study was to develop equations that predict the levels of emergence from vegetative propagules for four species of aquatic plants. We established artificial propagule banks by
growing monoecious and dioecious Hydrilla verticillata (L.f.) Royle, Potamogeton pectinatus L., P.nodosus Poiret and Vallisneria americana, L in outdoor tanks in Davis, California and Lewisville, Texas. Emergence of undisturbed propagules was monitored the following spring. In California, P. pectinatus tubers, P. nodosus winter buds, and axillary turions formed by monoecious H. verticillata began to sprout at about the same time in mid-February, while dioecious <italic>H. verticillata tubers did not begin to emerge until mid-August.
The distinct separations of emergence times for propagules in the Texas experiment were similar to those observed in California, except Vallisneria americana replaced monoecious <italic>H. verticillata. Using sediment temperature data from each location, we calculated degree-days using the single triangle method. We fit a single logistic equation relating cumulative emergence to accumulated degree-days for each species-propagule combination from the two locations.

Vegetative Propagation of Aquatic Plants by Leaf Cuttings.
Danielle Pierandozza, University of Florida - IFAS, Research & Education Center; David L. Sutton, University of Florida - IFAS, Research & Education Center, Fort Lauderdale, FL

Vegetative propagation of most plants occurs from nodes and apical meristems. However, a few species produce new plants from leaves. Information is lacking on the capability of aquatic plants to produce new plants from their leaves. Results will be presented on studies conducted (1) under mist in a greenhouse and (2) outdoors in pond water to evaluate vegetative propagation from leaves of hygrophila (Hygrophila polysperma (Roxb.) T. Anderson), alligatorweed (Alternanthera philoxeriodes (Mart.) Griseb.), mermaidweed (Proserpinaca palustris L.), parrotfeather (Myriophyllum aquaticum (Vell.) Verdc.), and primrose-willow (Ludwigia peruviana (L.) Ell.).
Student Paper

***Spartina Alterniflora* Invades San Francisco Bay/Delta: Impacts and Control Strategies.**
Lars W.J. Anderson, USDA-Agricultural Research Service Exotic and Invasive Weed Research, UC Davis, CA; Katy Zaremba, California State University, San Francisco, CA; Debra Smith, Bodega Marine Laboratory East Bay Regional Park District, Alameda/Contra Costa Counties; and Don Strong, University of California, Davis, CA

Spartina alterniflora, a cordgrass native to the U.S. East Coast, has become established in several San Francisco Bay sites and now occupies approximately 800 acres. It is displacing and hybridizing with the native West Coast cordgrass S. foliosa. As in Washington State, S. alterniflora is rapidly encroaching on the SF Bay open tidal mudflats and destroying this vital habitat where S. foliosa is not found. Building on experiences in Washington, control with Rodeo and cutting are being explored as well as use of Sonar SRP and the potential of burning to reduce dead thatch before herbicides are applied. The control program is complicated by the presence of listed species such as the clapper rail. A multi-agency technical working group has been formed to coordinate the overall program and Calfed funding has been proposed to implement a major control and eradication project.

Effects of an Altered Hydrological Regime on a Bottomland Hardwood Forest in Sampson County, North Carolina.
Heather D. Patti and Jon M. Stucky, Department of Botany, North Carolina State University, Raleigh, NC

We are examining the effects of soil saturation on water table, redox potential (F-h), plant species composition, and structure in 4 bottomland hardwood forest. Preliminary data were collected for one season, and a flashboard riser was installed in the main stream. The water table was raised and the soil redox potential lowered in response to riser installation. The structure and composition of the plant community has not changed substantially during the first year subsequent to riser installation. It is likely that the duration following riser installation was not long enough to observe changes in species composition, which may take one to several more years.
Student Paper

Formulation of a Fungal Pathogen for Biological Control of Hydrilla: A Challenging Task (WU# 32863)
Judy F. Shearer, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS

Mycoleptodiscus terrestris (Mt), a fungal pathogen of hydrilla, is currently undergoing formulation development as a bioherbicide. A prototype granular formulation that combined the fungus with a compatible EPA approved biocarrier, Biocar 405, was demonstrated to be efficacious on hydrilla in column and tank studies. Development of the formulation beyond the needs of small scale laboratory studies to a commercial bioherbicide necessitates major changes in formulation procedures and equipment. Fermentation must be optimized from benchtop to industrial fermentors that produce maximum fungal biomass in a defined medium. Extruding, drying, and milling apparatus must be upgraded from laboratory to commercial size units. Each change in the process may be concomitant with a change in the viability and pathogenicity of the fungus. Maintenance of the efficacy of the biological component through each step will be critical to the success or failure of the task.

Management Impacts on Tuber Sprouting and Population Dynamics of Dioecious Hydrilla.

Michael D. Netherland, SePRO Corporation, Carmel, IN

A greater understanding of the population and sprouting dynamics of hydrilla tubers is critical to developing improved management programs for this exotic aquatic plant. A series of research ponds near Gainesville, FL that have contained hydrilla since 1973 were treated in May 1995 with diquat + copper, endothall, fluridone, or grass carp. Monthly sediment core samples (40 / pond) were collected to determine tuber sprouting and population dynamics over a 36 month period. Results indicate that intense management resulted in a slow decline in hydrilla tuber populations over 36 months, yet tuber sprouting was not stimulated by any of the treatments compared to untreated controls. Tuber viability exceeded 90% throughout the study and sprouting was not influenced by depth distribution, tuber size, or sediment type. Sprouting tubers generally accounted for less than 2% of the total population at any given sampling period; however, peaks in sprouting (6%) were noted between October and November. Tuber populations in untreated control ponds increased slightly over the 36 month evaluation. Limited tuber production in untreated ponds was correlated with low rootcrown density (< 3 / m^2). In contrast, in treated ponds where hydrilla was allowed to recover, rootcrown densities > 45 / m^2 were recorded, and subsequent tuber production resulted in populations exceeding initial values. Drawdowns remain the only current control technique which has been demonstrated to stimulate sprouting of in situ hydrilla tubers.

Flowering, Seed Production, and Germination of Seed of Hygrophila.

Peter M. Dingler, University of Florida - IFAS, Research & Education Center, Fort Lauderdale, FL; David L. Sutton, University of Florida - IFAS, Research & Education Center, Fort Lauderdale, FL

Aquatic weeds possess qualities that allow them to make use of available resources at the expense of their neighbors. An understanding of the weed's life cycle helps provide insights into potential weaknesses in the plant's colonization, spread, and growth that may allow for effective control methods. Information is lacking on causes for the dramatic increases and continued spread of populations of hygrophila (Hygrophila polysperma (Roxb.) T. Anderson). Studies on flowering, seed production and germination, and germination tests of sediments collected from canals with infestations of hygrophila were conducted in an attempt to find potential weaknesses in its life cycle. Results of these findings will be discussed in relation to the spread of this noxious aquatic weed.

Student Paper

Allelopathic Effects of Common Reed on the Growth of Waterhyacinth and Some Economic Plants.

Sayed A. Ahmed and M.M. Khalifa Plant Protection Dept., Faculty of Agriculture, Assiut University and Plant Protection Research Institute, Assiut, Egypt

The allelopathic effects of aqueous leaf extract of common reed (Phrag7nites australis) on the growth of waterhyacinth (Eichhornia crassipes), germination and seedling growth of wheat (Triticum aestivum), clover (Trifolium alexal?drinum), radish (Raphanus satiius), garden rocket (Eurica saliva) and fenugreek (Trigonellafoenum graecum) were investigated. A concentration of the extract (1/4 w/v) significantly affected waterhyacinth plant growth causing >80% damage to the plants, a concentration of 1/8 w/v caused > 40% damage while no visual effect was observed due to the exposure to a concentration of 1/16 w/v, after 26 days of exposure. The highest injury rating was found 6 days after exposure. An adverse effect of the extract was demonstrated on the hypocotyl and radicle of the tested economic plants and the effect was generally conc. dependent.

Integrated Endothall and Mt Treatments for Control of Hydrilla. (WU# 32953)

L. S. Nelson and J. F. Shearer, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS

A growth chamber experiment was conducted to evaluate the efficacy of the herbicide endothall and the fungal pathogen Mycoleptodiscus terrestris (Gerd.) Ostazeski (Mt), applied alone and in combination with one another, against Hydrilla verticillata (L.f.) Royle (hydrilla). Treatments included low doses of endothall (0.25, 0.5, and 1.25 mg/L), 3 rates of Mt (100, 200, and 400 colony forming units (CFU) per ml, combined treatments of endothall (at all rates) with 100 or 200 CFU/ml Mt, and untreated controls. Sequential treatments were also assessed in which Mt was applied first, followed by endothall application 4 days later. Preliminary results indicate that simultaneous applications of endothall with Mt eliminated hydrilla biomass 5 days after treatment. Neither chemical nor fungal pathogen applied alone produced these same results. Treatments are currently being monitored for hydrilla regrowth. Based on the results of this laboratory study, an outdoor mesocosm experiment will be designed and conducted to determine the response and selectivity of integrated endothall + Mt treatments against hydrilla and non-target plant species.

Survivorship and Biomass Accumulation of North Carolina Juncus effusus and Vallisineria americana in Four North Carolina Lake Sediments.

Jon M. Stucky, Department of Botany, Stratford Kay and Steve Hoyle, Department of Crop Science, North Carolina State University

Vegetation is often slow to colonize impoundments and sparse in older impoundments and natural lakes. Sediment characteristics can contribute to this delayed colonization and sparseness. The purpose of this tank study was to evaluate the effects of four field collected sediments of varying fertilities and particle size distributions on the survivorships and five-month biomass accumulations of Juncus efusus and Valinsineria americana transplants. Sediment W/V (gm/cc 1) ranged from 0.80 (silt-loam) to 1.36 (sand); CEC (meq/100 cm) ranged from 2.4 (sand) to 7.6 (fine sandy loam). Survivorship and biomass accumulation for both species was loam>fine sandy loam>sand>Clay.

Economics of Aquatic Plant Management: Looking at the Costs Side. (WU# 31557)

Jim E. Henderson, U.S. Army Engineer Research and Development Center, Vicksburg, MS

Evaluations of herbicide eradication of milfoil at three lakes in Washington demonstrated total cost savings (since treatment), of between 45% ($34,000) and 53% ($275,000) (1998 dollars), compared to costs of alternative (mechanical) treatment. At lakes in the Midwest, ability to use reduced herbicide concentrations resulted in average cost savings of 74% ($34,000) compared to herbicide use at label concentrations. For flowing water systems (rivers), where annual treatment is required, improved herbicide treatments on ten miles of a Florida river reduced average yearly costs by ten percent ($12,000; 1997 dollars). These cost savings are significant for resource management agencies. Ongoing work is examining whether costs savings can be identified for biological controls.

Influence of Flooding on Growth of Pond Apple.

Lyn A. Gettys, North Carolina State University, Department of Horticultural Sciences, North Carolina State University, Raleigh, NC; David L. Sutton, University of Florida - IFAS, Research & Education Center, Fort Lauderdale, FL

Pond Apple (Annona glabra L.) is classified as an obligate wetland species. To provide additional information on growth of Pond Apple, young plants were cultured under flooded and terrestrial conditions. Measurements for height and dry weight showed that better growth was achieved with plants rooted in well-drained standard commercial potting media than with those rooted in sand flooded with pond water. These data suggest that young Pond Apple plants prefer a well-drained environment for optimum growth.

Student Paper

Potential Recruitment of Sunfishes in a Vegetated Reservoir Based on Larval and Juvenile Fish Abundance.
(WU# 32944)

K. Jack Killgore, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS and William D. Pearson, University of Louisville, Department of Biology, Louisville, KY

We sampled larval and juvenile sunfishes (Lepomis spp, Enneacanthus spp) in hydrilla (Hydrilla verticillata) over three years in Lake Marion, South Carolina. Catch was substantially higher in 1990, the year after floods created by a hurricane suppressed spring plant growth. Reduced plant growth during spring may have expanded unvegetated nesting sites for sunfish and increased spawning success. Electroshocking data collected from 1990 to 1996 indicates strong year-classes of several centrarchid fishes several years after the flood. Our results indicate that aquatic plant management can influence recruitment of sunfishes by suppressing plant growth during the spring, thus increasing suitable nesting sites.

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Session IV

The Spread and Spread of *Salvinia molesta.*

David S. Mitchell, Charles Sturt University, Albury, Australia

The aquatic fern, Salvinia molesta is a sterile pentaploid from South America. Since the 1930s it has spread through the tropics and sub-tropics. The plant is capable of doubling its population in less than 10 days in favourable field conditions and in less than 5 days in the laboratory. It interferes with a range of water uses, affects water quality and alters animal habitats. Strategies for the management of the weed will be suggeste on the basis of its ecology and of experience with it in some major infestations in different parts of the world.

The Status of Giant Salvinia (*Salvinia molesta*) in North Carolina.

Stratford H. Kay, Steve T. Hoyle, Crop Science Department, North Carolina State University, Raleigh, NC, and David T. Patterson, North Carolina Department of Agriculture and Consumer Services, Raleigh, NC.

Giant salvinia (Salvinia molesta) was found in October 1998 in a water garden display at the North Carolina State Fair in Raleigh. Surveys during December revealed that the weed was present in several aquatic nurseries and dealerships, one botanical garden, two golf course ponds and two rainwater retention ponds, as well as a few private water gardens in nine counties in the eastern piedmont and southeastern coastal plain. Field observations were made by NCSU, state regulatory agencies and others during the spring and summer of 1999. This paper reviews the weed's current distribution in North Carolina and action that has been taken.

Eradication of *Salvinia molesta* from a Small Pond in Colleton County, South Carolina.

Jack M. Whetstone, Clemson University, Georgetown; Steven J. de Kozlowski South Carolina Department of Natural Resources, Columbia, SC and Cynthia A. Aulbach, Botanical Services of South Carolina, Columbia, SC

Salvinia molesta, listed on the Federal Noxious Weeds List, was first documented in open waters of the United States in a small pond in Colleton County, South Carolina, in 1995, by representatives of Clemson University Cooperative Extension Service. An initial chemical application by the pond manager was not successful. Upon notification of Salvinia molesta infestation, SC Department of Natural Resources and USDA-APHIS established a complete eradication program under the direction of the Water Resources Division of SC Department of Natural Resources. Further chemical applications lead to complete eradication of Salvinia Molesta without further infestation of adjoining waterbodies.

Distribution, Prediction and Education: Key Components in Arresting the Spread of *Salvinia molesta* in the United States.

Colette Jacono, United States Geological Survey, Nonindigenous Aquatic Species Program, Gainesville, Florida.

Within a year of its 1998 discovery, the United States distribution of Salvinia molesta, giant salvinia, has increased to 6 states and over a dozen local watersheds. Its arrival has been linked to commercial nurseries around the country which serve as potential sources for introduction into new regions. Predicting regions susceptible to establishment will help understand the extent of national threat. Learning features for distinguishing giant salvinia from the previously introduced Salvinia minima, common salvinia, will aid in detecting infestations in the southeast. Public education holds the key to preventing new introduction and arresting spread in the US.

Biological Control and Integrated Management of *Salvinia molesta*.

Mic Julien, CSIRO Entomology, Long Pocket Laboratories, Indooroopilly, Australia

The floating aquatic weed salvinia or water fern (Salvinia molesta) has been troublesome throughout the tropics and subtropics. Floating mats of the weed covering water-bodies disrupted ecological processes, restricted or prevented fishing, transportation, irrigation and recreation, exacerbated flooding and incidence of disease, and reduce quality of the water. Its success as an exotic invader is due to its ability to fragment and disperse readily, grow rapidly, exploit a range of aquatic habitats and attract very few herbivores. Early unsuccessful releases of biological control agents during the 1970s included a weevil Cyrtobagous singularis, a grasshopper Paulinina acuminata and a moth Samea multiplicalis. These had been collected from northern South America from the Salvinia auriculata complex Later releases, beginning in 1980, included the moth S. multiplicalis and the salvinia weevil Cyrtobagous salvniae collected from the native range of S. molesta that had been identified as south-eastern Brazil. The salvinia weevil, but not the moth, provided extremely successful control of the weed. The fast rates and high levels of control achieved in Australia where it was first released lead to successful projects worldwide that have largely reduced salvinia to a minor problem. Estimates of benefit:costs for the Sri Lankan project were 53:1 in monetary terms and 1671:1 in labour terms. Extrapolations suggest global benefits exceeding Australia $200 million. There are habitats, e.g. salvinia growing as an under-story plant, and eco-climatic situations, e.g. permanent waterways that flow only during monsoonal wet seasons, that limit populations of the weevil and therefore compromise control. Integrated management strategies have been devised for some of these situations. In this presentation the biologies of the moth and the two Cyrtobagous weevils and a comparison of their interactions with the weed will be considered. Emphasis will be on C. salviniae, its attributes as well as s successful control agent and its limitations. Integrated management strategies based on biological control will be discussed.

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Session V

Establishment of Native Aquatic Plants for Habitat Enhancement, Mitigation for Aquatic Plant Management, and as a Deterrent to Exotic Species Invasions. (WU# 33084)

R. Michael Smart and Gary O. Dick, U.S. Army Engineer Research and Development Center, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX

The objective of this Aquatic Plant Control Research Program work unit is to develop guidance that will enable resource managers to successfully establish diverse communities of native aquatic plants. Factors affecting natural and artificial establishment of aquatic plants will be reviewed. Methods for producing plant propagules of selected species representing submersed, floating-leaved, and emergent growth forms will be presented. Methods of plant establishment (including herbivore protection) under different types of conditions will be discussed. Simple methods for monitoring the progress of establishment efforts will also be discussed.

Aquatic Plant Introduction Survey.

Michael Alexander, U.S. Army Corps of Engineers, Richard B. Russell Project, Elberton, GA

The Reservoir Committee of the Southern Division of the American Fisheries Society is conducting a national survey of state and Federal agencies, power companies, universities, and others to determine the use of aquatic plant introductions in habitat management programs. Information concerning planting methods, species used, success, etc. will be compiled into an aquatic plant introduction handbook that will be made available through the American Fisheries Society. The survey and preliminary results to date will be presented.

Establishment of Native Vegetation in El Dorado Lake, Kansas.

Gary 0. Dick, University of North Texas; R. Michael Smart, U.S. Army Engineer Research and Development Center, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX; Ron Marteney, Kansas Department of Wildlife and Parks, El Dorado, KS

El Dorado Lake, located in south central Kansas, is a moderately fluctuating Corps of Engineers' flood control reservoir. The Tulsa District and Kansas Department of Wildlife and Parks initiated a Section 1135 ecosystem restoration project designed to restore spawning and nursery habitat for fish by establishment of aquatic vegetation in the lake. Twenty species of submersed, floating-leaved and emergent plants were tested in the lake over a three-year period, with most of these established in founder colonies. Within protective e)closures, most plant species grew well and became established quickly. Unprotected plants did poorly. Spread from protected areas appeared to be limited by grazers, primarily common carp.

Restoring Fish Habitat with Native Aquatic Plants in Arcadia Reservoir, Oklahoma.

Eugene R. Gilliland, Oklahoma Department of Wildlife Conservation Fishery Research Laboratory Norman, OK; R. Michael Smart, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX

Aquatic vegetation was introduced into Arcadia Reservoir, Oklahoma in 1997 and 1998 to restore fish habitat. Twenty-two species of plants and several herbivore exclosures were evaluated. Obstacles included common carp, red-ear turtles and terrestrial herbivores which prevented plant expansion and beavers, muskrats and floating debris which damaged exclosures. Indoor production of plant propagules was unsuccessful due to inadequacies in light, temperature, and substrate. Fluctuating reservoir water levels caused problems in 1997 and a drought in 1998 exposed 90% of the vegetated plots. Recovery by several species provides hope that these techniques will, in time, prove successful in establishing mixed native plant communities and enhance recruitment of sport fish.

Evaluation of Methods for Establishing Native Aquatic Vegetation in Seven Texas Reservoirs.

Mark Webb, Texas Parks and Wildlife Department Bryan, TX; Michael Smart, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX; Vic DiCenzo, Spencer Dumont, Clell Guest, Richard Ott, Steve Poarch, and John Findeisen, Texas Parks and Wildlife Department, Austin, TX

Because many Texas reservoirs are either sparsely vegetated or contain an overabundance of non-native species such as hydrilla (Hydrilla verticillata), the Texas Parks and Wildlife Department, Inland Fisheries Division began a new initiative to develop procedures for establishing diverse native aquatic plant communities. The objective of the first phase of the initiative is to determine survival of introduced native aquatic vegetation planted in different exclosure types (to protect against herbivory) in 7 reservoirs representing a variety of ecological conditions. Two-month survival for plants protected by two levels of exclosures (small-scale exclosures within cove or shoreline fences) was 69% for submersed species, 76% for floating-leaved species and 90% for emergent species. Survival was considerably lower without protection from herbivory: 19% for submersed species, 35% for floating-leaved species, and 67% for emergent species.

An Integrated Approach to Managing Aquatic Plants at Lake Jacksonville, Texas.

Richard A. Ott, Jr., Texas Parks & Wildlife Department - Inland Fisheries, Tyler, TX; R. Michael Smart, U.S. Army Research and Development Center, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX

We developed an integrated management plan to control 48 ha of hydrilla (Hydrilla verticillata) on Lake Jacksonville, Texas (a 547-ha municipal water-supply reservoir). Our objective was to control a problematic, invasive, exotic plant while increasing coverage and community diversity of native plants for fish habitat. Our plan was to reduce hydrilla biomass with aquatic herbicide, stock a minimal number of grass carp (Ctenopharyngodon idella) to control re-sprouting, and introduce a diverse native plant community. Hydrilla was treated with Aquathol K (in summer 1997 and 1998 followed by stocking 100 grass carp each year. Following each treatment, native plants representing floating-leaved, emergent, and submersed growth forms were planted in protective cages (to limit herbivory). In fall 1998 hydrilla was found only in cages where native plant survival was low. Herbivores appeared to be selectively removing hydrilla from the plant community outside of the cages where it had been observed in summer 1998. Many of the native plant species introduced in 1997 and 1998 have survived and are expanding beyond the protective cages. These preliminary results indicate that an integrated approach has the potential to control hydrilla while promoting diversity of the native plant community.

Aquatic Plant Establishment as Restitution for a Fish Kill.

Ken Rice, Texas Parks and Wildlife Department, Corpus Christi, TX; Dr. R. Michael Smart, U.S. Army Research and Development Center, Lewisville Aquatic Ecosystem Research Facility, Lewisville, TX; Michael Reed, Texas Parks and Wildlife Department, Inland Fisheries Division, Ingram, TX.

In 1998, the Texas Parks and Wildlife Department initiated a four-year aquatic plant establishment project at Alice City Lake, Texas in an attempt to enhance fish and wildlife habitat. Funding for plants, materials and labor were provided by a local entity as negotiated settlement for its role in a public water fish kill. Two hundred and seventy-two individual plants of 19 species were planted within wire enclosures. Three-month survival averaged 73% for emergent, 48% for submersed and 71% for floating-leafed species. Species demon-strating greatest potential for establishment were water stargrass, American pondweed, water willow, softstem bullrush, pickerel weed, buttontounge, arrowhead, square-stem spike rush, white water lily, and spatterdock. A reservoir-wide survey of plant colonization will be conducted in late 1999. This project has provided a positive avenue for a local entity to provide restitution for a fish kill by assisting in improving fish and wildlife habitat.

Protecting the Native Aquatic Plant Communities of the Comal and San Marcos Rivers, TX.

Robert D. Doyle, University of North Texas, Denton, TX; Paula Power and Kathryn Kennedy, US Fish and Wildlife Service

The Comal and San Marcos Rivers of Texas are spring-fed rivers which are home to several endangered species and a diverse macrophyte community. Recent declines in macrophyte populations have created unvegetated areas. Unfortunately, exotic species such as hydrilla (Hydrilla verticillata) and hygrophila (Hygrophila polysperma) are poised to occupy these sites. Efforts are now underway to develop suitable techniques to allow the populations of native species to be bolstered. Native species being utilized include vallisneria (Vallisneria americana), red ludwigia (Ludwigia repens), strap-leaf sagittaria (Sagittaria platyphylla), Illinois pondweed (Potamogeton illinoensis), and Texas wildrice (Zizania texana). This presentation will provide an overview of the threats to the
native plant communities, as well as present specific methods utilized for re-introductions to the river. Initial results of the reintroduction efforts will be presented.

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Session VI

Using Remote Sensing and Mapping Technologies to Manage Large Scale Aquatic Plant Management Programs.

Terry McNabb and Steve Farone, Resource Management, Inc., Tumwater, WA

Most aquatic plant managers have to correctly solve a number of questions with a geographic component prior to making large scale treatments to solve aquatic plant problems. The location and exact acreage to be treated need to be accurately calculated and plotted. If the program is designed to restore habitat impacted by exotic vegetation to a pre-invasion condition remaining native plant communities need to be identified. Increasingly regulatory agencies may condition or deny permits because accurate information is not presented to them to make those decisions. Lastly, citizens need to have questions answered with respect to the potential impact of the operation on their lives. Remote Sensing and Mapping Technologies are playing a key role in answering these questions so programs can move forward. A number of technologies and their application to large scale aquatic plant management treatments will be presented.

A Review of Nautique, Laboratory, and Field Efficacy Results.

Tyler Koschnick, SePRO Corporation, Carmel, IN

Nautique is a new 9% chelated copper herbicide manufactured by SePRO Corporation, Nautique contains a triethanolamine ethylenediamine-copper complex that is effective in controlling many aquatic species, including Hydrilla verticillata, Najas Sp., Egeria Sp. and Ruppia maritima. it may be used in potable water reservoirs, freshwater lakes, ornamental, fish and fire ponds and fish and shrimp aquacultures. Preliminary lab evaluations to control Potamogeton pectinatus, Hydrilla verticillata, P. nodosus, Myriophyllum spicatum, and Vallisneria americana will be reviewed. Preliminary field evaluations from lake treatments, including applications on Webster Lake, Indiana will also be discussed.

Modeling Growth of Two Desirable Aquatic Macrophyto Species, Sago Pondweed, and American Wild-Celery.

Elly P. H. Best and William A. Boyd, U.S. Army Engineer Research and Development Center, Waterways Experiment Station, Vicksburg, MS

Models developed for two submersed plant species representing the characteristic life forms of submersed aquatic vegetation in the Upper Mississippi River System (UMRS) will be briefly discussed. Of these species, (1) Sago pondweed (Potamogeton pactinatus L.) is a canopy-formor which has the ability to survive unfavorable environmental conditions, and outcompete many other submersed aquatic plant species in temperate. subtropical, and tropical areas, while (2) American wild-celery (Vallisneria americans Michx.) it, a non-canopy-former which is less competitive and has a typical north-American geographical distribution. Models are based on carbon flow through a monotypic vegetation within a 1 -sqm water column. They include descriptions of several factors that affect biomass dynamics, such as site-characteristic changes in climate, water temperature, and pH and oxygen regime as far as they affect carbon assimilation rate at light saturation, wintering strategies, grazing, and mechanical control (removal of tubers or shoot biomass) and latitude, The application potential for use in the UMRS will be Illustrated.

Photo-History of the Aquatic Plant Control Program in the Jacksonville District.

Charles E. Ashton, U. S. Army Corps of Engineers, Jacksonville District, Aquatic Plant Control Section

A photographic history of the Aquatic Plant Control Program in the Jacksonville District will be presented. Included are photographs from the late 1800's to the present, featuring the various equipment and techniques utilized in an attempt to control invasive aquatic plants: such as the hyacinth destroyer, biological control with water buffalo, and zapping plants with carbon dioxide lasers. Also included are the current more conventional and successful methods utilized today.

Population Response of Triploid Grass Carp to Declining Levels of Hydrilla in the Santee Cooper Reservoirs, South Carolina.

James P. Kirk, J. V. Morrow, Jr., and K. J. Killgore, US Army Engineer Research and Development Center, Vicksburg, MS; S. J. de Kozlowski, South Carolina Department of Natural Resources, Columbia, SC; J. W. Preacher, U S Army Engineer District, Charleston, SC

Abstract: Approximately 768,500 triploid grass carp (Ctenopharyngodon idella Valenciennes) were stocked into the Santee Cooper reservoirs, South Carolina between 1989 and 1996 to control hydrilla (Hydrilla verticillata (L.f.) Royle). Hydrilla coverage was reduced from a high of 17,272 ha during 1994 to less than 10 ha in 1998. In 1994, 1997, and 1998 we collected 100 triploid grass carp yearly for population monitoring. Age, growth and mortality data developed using sectioned lipillar otoliths and scales, stocking records, and population models were used to monitor the population. Age-specific weights plummeted after hydrilla was eliminated. The annual mortality was estimated at 22% in 1994, 28% in 1997, and 32% in 1998; these mortality rates were not significantly different. However, we expect increased mortality and decreased growth while hydrilla coverage remains sparse. During 1999, we estimated about 77,000 triploid grass carp in the system and many older fish were stunted. Population models project less than 11,000 fish by 2003, assuming no future stockings. Incremental stocking of triploid grass carp was successful in not only eliminating hydrilla but in preventing regrowth. In this regard, periodic monitoring of hydrilla regrowth and the triploid grass carp population should allow aquatic plant managers to maintain control of hydrilla.

Aquatic Moth Stops Formation of Eurasian Watermilfoil Canopy.

Robert L. Johnson, Cornell University, Division of Biological Sciences, Section of Ecology and Systematics, Ithaca, NY

Eurasian watermilfoil (Myriophyllum spicatum L.) elongates to the surface forming a dense canopy early in the growing season. Native plant species decline, unable to compete for available sunlight and space because of this early season canopy formation. Aquatic moth larvae (Acentria ephemerella) cause significant limitation of watermilfoil growth during lake enclosure study at densities of <1 individual per apical meristem. Second to fifth larval instars of Acentria specifically attack the apical meristem of watermilfoil halting stem elongation. Minor feeding, at the apical meristems, by these larvae cause immediate cessation of elongation and permanent damage to growing tips of young watermilfoil.

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